Has Perchlorate in Drinking Water Increased the Rate of Congenital Hypothyroidism?

Running Title: Perchlorate and Congenital Hypothyroidism

Word Count: 777

Steven H. Lamm, MD & Martha Doemland, PhD

From Consultants in Epidemiology and Occupational Health, Inc. (CEOH, Inc.), Washington, DC (Drs. Lamm and Doemland)

Authors' Present Positions

1. Steven H. Lamm, MD, DTPH – Chief Scientist, CEOH
2. Martha Doemland, PhD (Epi) – Epidemiologist, CEOH

Address Correspondence and Reprint Requests to Steven H. Lamm at:
Consultants in Epidemiology and Occupational Health, Inc.
2428 Wisconsin Avenue, NW Washington, DC 20007

Funded by American Pacific Corporation, 3770 Howard Hughes Parkway, Suite 300 Las Vegas, Nevada 89109

Prepared for submission to:
Journal of Occupational and Environmental Medicine, January 19, 1999

Abstract

Perchlorate, known to inhibit the human thyroid at doses above 200 mg/day, was detected in the drinking water supplies of seven counties in California and Nevada at levels of 4 to 16 ug/l in 1997. The data from the neonatal screening programs of the state health departments were analyzed for any increased incidence of congenital hypothyroidism in those counties. County-specific, ethnicity-specific data for Nevada and California were obtained for 1996-1997. Within these seven counties, nearly 700,000 newborns had been screened. 249 cases were identified, where 243 were expected, for an over all risk ratio of 1.0 (95% confidence interval, 0.9-1.2). The risk ratios for the individual counties ranged between 0.6 and 1.1. These data in this ecological analysis do not indicate an increase in the incidence of congenital hypothyroidism with the reported perchlorate levels.

Keywords: Perchlorate, thyroid, congenital hypothyroidism

Introduction

Congenital hypothyroidism is a preventable cause of mental retardation and is detected at birth through neonatal screening programs. Perchlorate, now a known environmental contaminant of drinking and surface waters, is known to block thyroid hormone formation by competitively inhibiting the uptake of iodine by the thyroid gland. An analysis has been conducted to determine whether the counties with perchlorate-containing water have an increased rate of congenital hypothyroidism.

Methods

The source of perchlorate contamination in California and Nevada originated from industrial sites manufacturing or using perchlorate for missiles, rockets, or fireworks. Contamination below an industrial site in Nevada led to contamination of Lake Mead. Lake Mead is the source of both the Colorado River water supply for Southern California and the water supply for Las Vegas (Clark County) Nevada. Perchlorate measurements in the Colorado River water have been 5-8 ppb (ug/l). Perchlorate measurements in the Clark County water supply have been up to 16 ppb (EPA, 1998). The US Environmental Protection Agency (EPA) Region 9 has identified six counties in California and one in Nevada as having perchlorate in the drinking water supply. (Figure I)

The health departments of both Nevada and California have conducted neonatal screening programs for congenital hypothyroidism for over ten years. A heel-stick blood sample of all newborns is used to assess the presence of a variety of congenital metabolic diseases.

Participation is mandatory and covers all hospitals with birthing units. Follow-up after diagnosis and referral for treatment is supervised by the state health departments.

The county-specific congenital hypothyroidism case counts and live birth counts for 1996 and 1997 have been obtained for both California and Nevada. These data were supplied by the respective state Health Departments (George Cunningham, MD, MPH, Chief of the Genetics Disease Branch, Primary Care & Family Health Division, California Department of Health Services; Gloria Dayhli, Bureau of Family Health Services, Nevada State Health Division). The California data were stratified by ethnicity since fifty percent of California births are Hispanic and Hispanic ethnicity has been shown to be a risk factor for congenital hypothyroidism (Lorey & Cunningham, 1992).

Results

California and Nevada comprise a population of about 35 million people with a birth rate of about sixteen percent. The neonatal screening programs cover essentially one hundred percent of the live births in each state, including the 700,000 newborns who were screened during 1996-97 in the seven counties with perchlorate-contaminated drinking water.

Based on state incidence rates of congenital hypothyroidism, 243 cases would have been expected in the seven county area during 1996-1997 and 249 cases were observed [Table 1]. This risk ratio is 1.02 (95% confidence limits, 0.9-1.2). The risk ratios (congenital hypothyroidism standardized birth prevalence ratio) were calculated for the individual counties and ranged between 0.6 and 1.1. Thus, in Nevada and California, the counties with detectable

levels of perchlorate in the drinking water had congenital hypothyroidism prevalence rates that did not differ from the expected based on state rates.

Nearly the entire water supply for Clark County, Nevada comes from the primary source of perchlorate contamination (Lake Mead). The California counties have more spotty and intermittent exposure. Nonetheless, this ecological examination of the congenital hypothyroidism data (1996-97) shows no increase in the prevalence of congenital hypothyroidism in counties with detected perchlorate levels in the drinking water.

Discussion

Perchlorate was detected in the range of 4-16 ppb (μg/l) in drinking water supplies for California and Nevada. Assuming water intake of two liters per day, this might provide a daily dosage of perchlorate of approximately 20 μg per day. A daily intake rate of perchlorate at 20 μg per day can be compared with the minimum effective dose of 200 mg/day (200,000 μg/day) that has been used medically to suppress the thyroid in treatment of hyperthyroidosis.

Congenital hypothyroidism occurs when both the maternal thyroid and the fetal thyroid are unable to supply adequate thyroid hormone to the fetus. This occurs endemically only in the presence of severe iodine deficiency, a condition rarely known in the United States, and sporadically with structural or metabolic defects in the thyroid. Children born without a thyroid have normal intellect if thyroid treatment starts early because the maternal thyroxine that crosses the placenta is usually sufficient to sustain the fetus (Burrow and Fisher, 1994; Vulsma et al.,

1989; Larsen, 1989). Even moderate iodine deficiency in a population yielded only transient changes in thyroid hormone levels (T_4, TSH) and no increase in congenital hypothyroidism (Delange et al., 1986).

Comparison of the county-specific rates of congenital hypothyroidism (based on prevalence rates derived from mandatory reporting programs) in California and Nevada reveal that counties with detected levels of perchlorate in the drinking water do not have higher rates of congenital hypothyroidism. These data, at an ecological level of analysis, seem to indicate that no increased rate of congenital hypothyroidism is associated with the levels of perchlorate found in the drinking waters of California and Nevada.

References

Environmental Protection Agency. Office of Ground Water and Drinking Water. Perchlorate. December 15, 1998.

Lorey FW and Cunningham GC. Birth Prevalence of Primary Congenital Hypothyroidism by Sex and Ethnicity. Human Biology, Aug 1992; 64(4): 531-538.

Burrow GN, Fisher DA, and Larsen PR. Mechanisms of Disease: Maternal and Fetal Thyroid Function. NEJM, 1994 Oct 20; 331(16): 1072-1078.

Vulsma T, Gons MH, de Vijlder JJ. Maternal-Fetal Transfer of Thyroxine in Congenital Hypothyroidism due to a Total Organification Defect or Thyroid Agenesis. NEJM, 1989 Jul 6; 321(1):13-16.

Larsen PR. Maternal Thyroxine and Congenital Hypothyroidism. NEJM, 1989 Jul 6; 321(1): 44-46.

Delange F, Heidemann P, Bourdoux P, Larsson A, Vigneri R, Klett M, Beckers C, and Stubbe P.: Regional variations of iodine nutrition and thyroid function during the neonatal period in Europe. Biol. Neonate, 1986; 49: 322-330.

Congenital Hypothyroidism Cases (Observed and Expected*) for 1996 and 1997 in Nevada and California Counties with Perchlorate Reported in Water Supply

State	County	Newborns Screened	Congenital Hypothyroidism Cases			
			Observed	Expected	Observed/ Expected	95% Conf. Limits
Nevada	Clark	36,016	7	8.3	0.84	(0.34-1.74)
California	Los Angeles	338,934	136	123.5	1.10	(0.92-1.30)
	Orange	101,227	40	35.9	1.12	(0.80-1.52)
	Riverside	43,577	11	15.6	0.71	(0.35-1.26)
	Sacramento	39,235	8	12.9	0.62	(0.27-1.22)
	San Bernardino	51,637	17	18.4	0.92	(0.54-1.48)
	San Diego	80,582	30	28.2	1.06	(0.72-1.52)
	Total	655,192	242	234.6	1.03	(0.90-1.16)
Nevada and California		691,208	249	242.9	1.02	(0.90-1.16)

* Expected numbers have been adjusted for Hispanic ethnicity.

Figure 1. Counties in California and Nevada with Perchlorate Detected in Drinking Water